INDOOR AIR QUALITY ASSESSMENT

Belmont Police Department
460 Concord Road
Belmont, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
Emergency Response/Indoor Air Quality Program
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Background/Introduction

In response to a request from a building occupant, an indoor air quality assessment was done at the Belmont Police Station (BPS) at 460 Concord Road, Belmont, Massachusetts. This assessment was conducted by the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA). On December 5, 2002 a visit was made to this building by Cory Holmes, Environmental Analyst of the Emergency Response/Indoor Air Quality (ER/IAQ) Program. Donna Moultrup, Director and Patrick McCormack Town Sanitarian (Belmont Health Department) accompanied Mr. Holmes during the assessment. Reports of respiratory irritation as well as temperature and ventilation complaints prompted the assessment.

The BPS is a two-story red brick building with a basement originally constructed in 1931. The building was renovated in 1995, which included interior work as well as the replacement of a roof. Exterior brickwork was also reportedly repointed in a number of areas over the last several years. The first floor of the BPS consists of the prisoner-processing area, holding cells and the patrol room, locker rooms, kitchen, dispatch area and several offices. Office space is located on the second floor. The attic is used for storage and contains one of three air handling units as well as computers and communications equipment. The basement contains a garage, boiler room, and a large open area (activity room).

Methods

Air tests for carbon dioxide, carbon monoxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor.

Results

The BPS operates 24 hours a day, has a staff of 65-70 and is visited by approximately 100 members of the public daily. The tests were taken under normal operating conditions. Test results appear in Tables 1-2. Air samples are listed in the tables by location that the air sample was taken.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were below 800 parts per million parts of air [ppm] in all areas surveyed, indicating adequate air exchange. An HVAC system provides ventilation through ducted, floor and ceiling vents (see Pictures 1 & 2), connected to three air handling units (AHUs). One AHU is located in the attic. The second is located on the ground floor near the garage. The third is located in a loft in the activity room (see Pictures 3-5). The attic and loft AHUs were connected to outside air intakes. BEHA staff could not identify if the ground floor AHU in Picture 4 was capable of introducing fresh air into the system; since no obvious fresh air intakes for this equipment could be identified.

The ventilation system is controlled by thermostats (see Picture 6). Thermostats have a fan control, which can be set to either "auto" or "on". At the time of the assessment, switches were set to "auto", which deactivates the AHUs once the temperature set on the thermostat is measured. BEHA staff recommended that the fan switch be placed to the "on" position to provide continuous airflow to the space. Without mechanical ventilation running continuously, fresh air cannot be introduced on a consistent basis. In addition, floor vents in the dispatch area were obstructed by equipment, which can impede airflow (Picture 7). Exhaust ventilation in occupied areas is provided by wall and/or ceiling-mounted exhaust grilles, which return air to the AHU via ductwork.

The attic is ventilated by wind-driven turbine vents (see Picture 8). As the wind turns the blades of the turbine fan negative pressure is created in the attic space, which pulls out excess heat.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of occupancy. In order to have proper ventilation with a mechanical ventilation system, the system must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The date of the last balancing of these systems was not available at the time of the assessment. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please consult Appendix I of this assessment.

Temperature measurements ranged from 69° F to 73° F, which were very close to the BEHA recommended comfort range. The BEHA recommends that indoor air temperatures be maintained in a range of 70° F to 78° F in order to provide for the comfort of building occupants. Uneven heating and cooling were expressed to BEHA staff, specifically excess heat in the dispatch area. The dispatch area contains large amounts of communication and computer equipment, and shares a thermostat that is located in the first floor hallway, with other areas of the building (e.g. offices). In this configuration the thermostat reads temperatures, which are not representative of the dispatch area making it difficult to control temperature.

The relative humidity in this building ranged from 16 to 20 percent, which is below the BEHA recommended comfort range. The BEHA recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

Water damaged ceiling tiles and wall/ceiling plaster were observed in several areas of the building (see Tables/Picture 2), which are evidence of roof or plumbing leaks. Water-damaged ceiling tiles, and other porous building materials, can provide a source of microbial growth and should be replaced after a water leak is discovered. Occupants reported an active leak in the men's restroom that occurs during wind-driven rain storms. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous materials be dried with fans and heating within 24 hours of becoming wet (ACGIH, 1989). If these materials are not dried within this time frame, mold growth may occur. Once mold has colonized porous materials, they are difficult to clean and should be removed.

In several areas around the building, small trees/stumps and other plants were growing against the foundation and clinging plants were noted on exterior walls (see Pictures 9 & 10). The growth of plants/roots against the exterior walls and along the foundation can bring moisture in contact with wall brick and eventually lead to cracks and/or fissures in the foundation below ground level. Clinging plants can cause water damage to brickwork by inserting tendrils into brick and mortar. Water can penetrate into the brick along the tendrils, which can subsequently freeze and thaw during the winter. This freezing/thawing action can weaken bricks and mortar, resulting in wall damage.

Other Concerns

Several other conditions that can potentially affect indoor air quality were also identified. A garage is located at ground level to the rear of the building. The garage was being used to store a number of automobile tires, a motorcycle, a freezer containing road kill and a number of other items (see Picture 11). The fuel tank of the motorcycle may provide a source of possible odors due to volatile organic compounds (VOCs) found in gasoline that can off gas and have an adverse effect on indoor air quality. Rubber of new tires can also give off an acrid odor, which can be enhanced by heating. The hallway door to the garage was propped open (see Picture 12). When the garage door is open for vehicle entry/exit, the garage can become pressurized forcing odors from stored items into the ground floor. Also noted was the lack of a door on the boiler room (see Picture 13). Located on the ground floor mezzanine is one of the AHU (see Picture 4), which can draw odors (e.g. fuel, rubber, gasoline odors) into the ventilation system and distribute them throughout the building.

Lastly, periodic sewer gas odors were reported in the men's locker room. The locker room is equipped with floor drains that are equipped with traps. A trap forms an airtight seal when water is poured down the drain. Without regular input of water, traps can dry out and allow for sewer gas to back up into the building. Sewer gas can be irritating to the eyes, nose and throat.

Conclusions/Recommendations

In view of the findings at the time of this visit, the following recommendations are made:

1. A preventative maintenance program for all HVAC equipment should be developed and implemented, which should include changing filters for AHU equipment as per the manufacturer's instructions or more frequently if needed, as well as the examination of all HVAC equipment periodically for maintenance and function.

2. Operate HVAC system in the fan "on" setting. To maximize air exchange, the BEHA recommends that mechanical ventilation *operate continuously* during periods of occupancy independent of thermostatic control.
3. Consider having the ventilation system balanced by an HVAC engineer every five years (SMACNA, 1994).
4. Repair and/or replace thermostats as necessary to maintain control of comfort. Consider the feasibility of installing a separate thermostat to control ventilation in the dispatch/communications area and/or the installation of a supplemental cooling unit/air conditioner.
5. Remove all blockages from air vents to ensure adequate airflow.
6. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Avoid the use of feather dusters. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
7. Remove plant growths against the exterior wall/foundation of the building to prevent water penetration.
8. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. Drinking water during the day

can help ease some symptoms associated with a dry environment (throat and sinus irritations). Consider obtaining a vacuum cleaner equipped with a high efficiency particulate arrestance (HEPA) filter to trap respirable dusts. Wet wiping of flat, nonporous surfaces would also remove accumulated dust that can become aerosolized.

9. Remove plant growths against the exterior wall/foundation of the building to prevent water penetration.

10. Consider increasing the dust-spot efficiency of HVAC filters. Prior to any increase of filtration, each piece of air handling equipment should be evaluated by a ventilation engineer as to whether it can maintain function with more efficient filters.

11. Install airtight door to boiler room and keep garage door shut to prevent entrainment of odors into the ventilation system.

12. Pour water down floor drains in men's locker room twice weekly or more if needed; have the plumbing system inspected by a licensed plumbing firm to ensure proper function.

References

ACGIH. 1989. Guidelines for the Assessment of Bioaerosols in the Indoor Environment. American Conference of Governmental Industrial Hygienists, Cincinnati, OH.

BOCA. 1993. The BOCA National Mechanical Code-1993. 8th ed. Building Officials & Code Administrators International, Inc., Country Club Hills, IL. M-308.1

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R. 1910.1000 Table Z-1-A.

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

SMACNA. 1994. HVAC Systems Commissioning Manual. 1st ed. Sheet Metal and Air Conditioning Contractors' National Association, Inc., Chantilly,

Picture 1

Typical Floor Supply Vent for HVAC System

Picture 2

Typical Ceiling Supply Vent for HVAC System, Note Water Damaged Ceiling Plaster

Picture 3

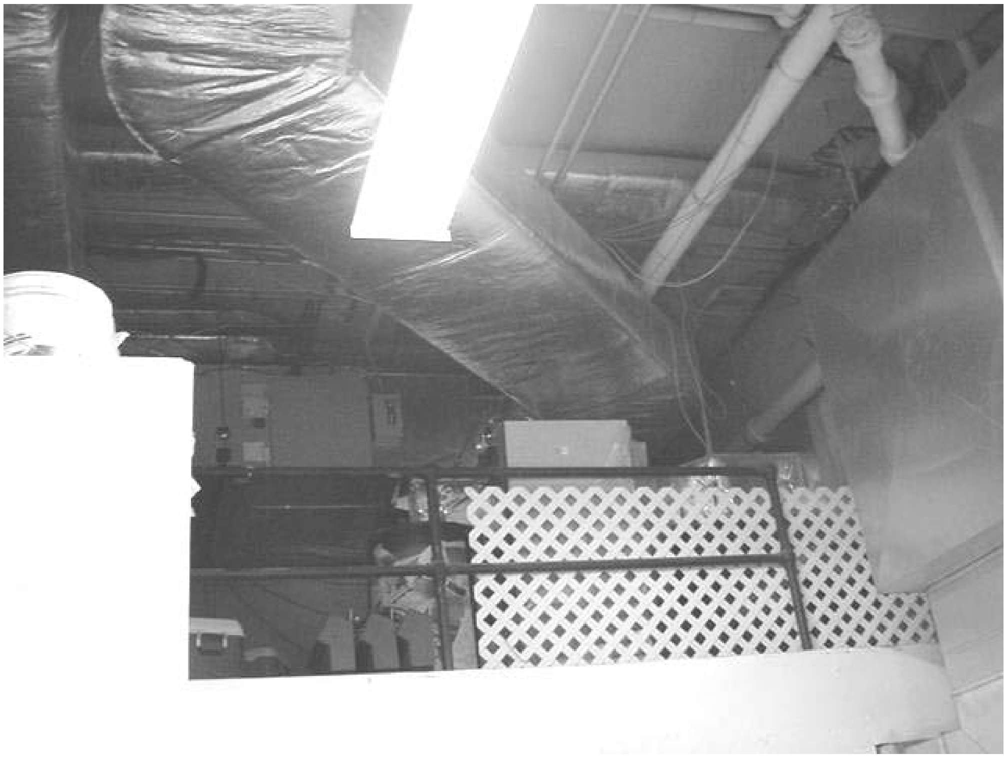
AHU Located in Attic, Note Ductwork to Air Intake on Exterior Wall

Picture 4

Air Intake/Return Vent

AHU on Ground Floor Mezzanine, across from Garage

Picture 5



AHU Located in Loft in the Activity Room

Picture 6

Thermostat Set in the Fan "Auto" Setting

Picture 7

Obstructed Floor Vent in Dispatch/Communications Area

Picture 8

Wind-Driven Turbine Vents on Roof

Picture 9

Plant/Tree Growth Against the Foundation of Building

Picture 10

Clinging Plants on Exterior Wall

Picture 11

Interior of Garage, Note Stored Items

Picture 12

Interior Garage Door Propped Open

Picture 13

Boiler Room Entrance Without Door

TABLE 1

Indoor Air Test Results –Belmont Police Department, Belmont, MA . – December 5, 2002

Location	Carbon Dioxide *ppm	Temp °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
(Background) Outside	440	44	18					Overcast and cold
Report Room	667	70	24	0	Y	N	N	Computer equipment
Interview Room	680	69	22	0	Y	Y	Y	Dislodged CT Water-damaged CT
OIC Office	606	70	21	3	N	Y		Ceiling fan
Reception	593	70	21	0	N	Y	N	
Dire Pu S	610	70	21	0	Y	N	N	
Dispatch Area	625	71	20	3	Y	Y	Y	Computer equipment, share thermostat with office space, ceiling fans
Locker Room	618	70	20	0	Y	Y		Stained CT, water cooler on carpet Water-damage, peeling paint
Restroom	614	69	19	0	N	N	Y	Light switch activated
1st Floor Shift Room	583	70	19	0	N	Y	Y	
Men's Locker Room	575	69	19	0	Y	Y	Y	Historic water damage, periodic sewer odors Stained CT/shower drain, floor drains

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 2

Indoor Air Test Results –Belmont Police Department, Belmont, MA . – December 5, 2002

Location	Carbon Dioxide *ppm	Temp °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
Women's Locker Room	600	70	20	0	Y	Y	Y	
Records	693	72	19	4	Y	Y	N	Photocopier Floor vent/ceiling fans
T Office	600	72	17	0	Y	Y	N	Thermostat fan "auto"
Kitchen	550	72	16	0	Y	Y	N	CT
2n Floor Hallway								Water-damaged plaster
Capt O'Malley	593	72	17	0	Y	Y	N	Window open
Detectives	662	73	17	0	Y	Y	N	
Chief's Corner Office	652	72	17	0	Y	Y	N	Historic water damage from AC Leak – walls
Chief's Office	615	72	18	1	Y	Y	N	
Attic						Y	N	
Basement, Mezzanine								AHU-no obvious source of fresh air

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